Ministry
of
Transportation
Ontario

# MI-154

## THE QUALITY OF RUBBERIZED ASPHALT CRACK SEALER FOR ASPHALT PAVEMENTS SUPPLIED IN 1991

## MATERIALS INFORMATION

### ENGINEERING MATERIALS OFFICE

# THE QUALITY OF RUBBERIZED ASPHALT CRACK SEALER FOR ASPHALT PAVEMENTS SUPPLIED IN 1991

92-05771/

by

D. C. Pearson

and

D. F. Lynch

ENGINEERING MATERIALS OFFICE
BITUMINOUS SECTION
MAY 1992

ISBN 0-7729-9938-4

**Canadian Cataloguing in Publication Data**

Pearson, D. C.
The quality of rubberized asphalt crack sealer for asphalt pavements supplied in 1991

"MI-154".
ISBN 0-7729-9938-4

1. Asphalt-rubber. 2. Pavements, Asphalt–Ontario–Cracking. I. Lynch, D. F. II. Ontario. Transportation Engineering and Standards Branch. Engineering Materials Office. III. Title.

TE270.P42 1992 625.8'5'09713 C92-092566-9

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# TECHNICAL REPORT DOCUMENTATION

THE QUALITY OF RUBBERIZED ASPHALT CRACK SEALER FOR ASPHALT PAVEMENTS SUPPLIED IN 1991

Authors: D. C. PEARSON AND D. F. LYNCH

Abstract:

Rubberized asphalt crack sealers are used to seal cracks in asphalt pavements to prevent the intrusion of water in order to preserve the strength of the pavement structure - particularly during cycles of freezing and thawing.

Two types of crack sealer are approved for use by the Ministry. "Districts 1-8 Only" product may only be used in the southern part of the Province while "All Districts" product is approved for use anywhere in the Province including the more severe environmental conditions experienced in the North.

In 1991, a total of 19 crack sealing contracts were awarded by the Ministry in 13 Districts. These contracts amounted to nearly 912,000 metres of cracks requiring almost 456,000 kg of crack sealer. Typically, crack sealing costs about $1.00 per linear metre. Twenty samples of eight different types of crack sealer were tested in the Ministry's Downsview laboratory. Sixty-seven per cent of the samples of "Districts 1-8 Only" crack sealer did not conform to the specification. None of the samples of "All Districts" crack sealer conformed to the contract requirements.

This report summarizes the results of the sampling and testing and recommends improvements to the Ministry's acceptance system for these materials.

Abrégé:

Les produits caoutchoutés de scellement des fissures sont appliqués sur les revêtements bitumineux pour empêcher la pénétration de l'eau et protéger la structure de la chaussée, surtout pendant les périodes de gel et de dégel.

Le ministère a approuvé deux types de produits de scellement des fissures : ceux ne pouvant être utilisés que dans les districts 1 à 8, soit dans le Sud de la province, et ceux pouvant être appliqués dans toute la province et qui résistent au rude climat du Nord.

En 1991, le ministère a conclu 19 contrats dans 13 districts pour le scellement des fissures. Ces contrats ont permis le scellement de près de 912 000 mètres de fissures et ont nécessité quelque 456 000 kg de produits. Le scellement des fissures coûte généralement 1 $ le mètre linéaire. Vingt échantillons de huit types de produits de scellement ont été analysés au laboratoire du ministère, à Downsview. Soixante sept pour cent des échantillons de produits utilisés dans les districts 1 à 8 n'étaient pas conformes aux spécifications, et aucun des échantillons de produits pouvant être appliqués dans tous les districts ne satisfaisaient aux exigences des contrats.

Le présent rapport résume les résultats de l'échantillonnage et des analyses et recommande diverses mesures pour améliorer le système d'approbation de ces produits par le ministère.

Keywords: Crack Sealer, Asphalt Pavement, Rubberized, Quality, Laboratory Testing, Designated Sources List

Published by: ENGINEERING MATERIALS OFFICE
3rd Floor, Central Building
1201 Wilson Avenue
Downsview, ONTARIO
CANADA M3M 1J8

Date: MAY 1992

Report Number: MI-154
ISBN 0-7729-9938-4

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## 1. INTRODUCTION

Rubberized asphalt crack sealers are used to seal cracks in asphalt pavements in order to minimize the ingress of water into the structure and thus prevent further deterioration of the pavement.

The current Ministry procedure is a rout, clean and seal method described in a non-standard special provision (June 25, 1990) attached to this report as Appendix 1. Only those materials listed on the Ministry's Designated Sources Lists (DSL) No. 3.05.40 "Joint Seal Rubberized Asphalt, Hot Poured" are permitted to be used on Ministry work.

## 2. DESIGNATED SOURCES LIST

The DSL identifies two types of crack sealing products. "Districts 1-8 Only" product can only be used in the southern part of the Province, south of the 45th parallel. In order to have a product included in this section of the DSL, a supplier is required to submit a sample to the Ministry's Downsview Laboratory where it is tested for compliance with OPSS 1212 "Material Specification for Hot-Poured Rubberized Asphalt Joint Sealing Compound". If the sample meets all the requirements of the specification, it is included on the DSL for "Districts 1-8 Only" product.

"All Districts" product is permitted to be used anywhere in the Province, including the more severe environmental conditions north of the 45th parallel. Before these "All Districts" products can be included on the DSL they must be approved by a field trial constructed north of the 45th parallel. Only those sealers which maintain better than 90 per cent integrity in transverse cracks over a one winter cycle are considered for listing. Once proven, further shipments of the product must maintain essentially the same test properties as the material supplied for the approval trial.

Field trials are generally carried out on sections of Highway 11 or Highway 69 in Huntsville District for three major reasons:

1. Both highways carry a significant volume of traffic year round (greater than 7,000 Annual Average Daily Traffic).

2. By always carrying out the trials in generally the same location, all sealants are subjected to the same assessment - the "playing field" is kept level.

3. Both sites are within a one day journey from Downsview which minimizes the time and cost involved in the construction and monitoring of the trials.

## 3. 1991 MINISTRY USAGE

In 1991, thirteen of the Ministry's eighteen Districts awarded a total of nineteen crack sealing contracts. Eight different crack sealing materials were used to seal nearly 912,000 linear metres of cracks. It is estimated that this represents about 456,000 kg of crack sealer. Ministry policy regarding the sampling and testing of rubberized crack sealers is not clear. Directive B-42 "Minimum Frequencies of Production Sampling and Testing" specifies that one sample per contract be obtained for testing. However, the Inspection, Sampling and Testing of Designated Sources Materials Directive DS-143.4 specifies that one sample should be taken per 5 km of 2-lane highway. The Inspection Task Manual specifies that the material supplied by the contractor be sampled as required.

At least one sample was submitted for testing from 14 of the 19 crack sealing contracts. This represents 74 per cent of the total contracts or 88 per cent of the total linear metres of cracks sealed.

Because of laboratory time constraints, it was not possible to test all of the 45 samples submitted by the Districts. At least one sample was tested from each contract on which samples were taken and a total of 20 samples were tested in all which represents 44 per cent of the samples submitted.

Table 1 provides a summary of crack sealing usage on Ministry contracts in 1991, including the sampling and testing.

Table 1
Summary of 1991 Crack Sealing Contracts
on Asphalt Pavements

| District | Material | Contract Size (Linear m) | Estimated Material Usage (kg) * | Samples Taken | Samples Tested |
|---|---|---|---|---|---|
| No. 6,7,8,9,11 No crack sealing on asphalt pavements carried out in 1991 | | | | | |
| No. 1 | A | 86,685 | 43,343 | 5 | 1 |
| No. 2 | B | 81,800 | 40,900 | 3 | 2 |
| No. 3 | C | 7,525 | 3,763 | 1** | 0 |
| | A | 4,274 | 2,137 | 0 | 0 |
| No. 4 | B | 22,057 | 11,029 | 0 | 0 |
| No. 5 | C | 31,608 | 15,804 | 1 | 1 |
| | C | 19,880 | 9,940 | 1 | 1 |
| | C | 10,924 | 5,462 | 1 | 1 |
| | C | 21,986 | 10,993 | 1 | 1 |
| No. 10 | D | 90,216 | 45,108 | 5 | 1 |
| No. 13 | E | 117,368 | 58,684 | 1 | 1 |
| No. 14 | F | 51,162 | 25,581 | 17 | 4 |
| No. 16 | A | 44,355 | 22,178 | 2 | 2 |
| No. 17 | D | 140,808 | 70,404 | 1 | 1 |
| No. 18 | G | 8,073 | 4,037 | 1 | 1 |
| No. 19 | H | 72,500 | 36,250 | 0 | 0 |
| No. 20 | E | 17,126 | 8,563 | 2 | 2 |
| | E | 83,171 | 41,586 | 3 | 1 |
| | E | 467 | 234 | 0 | 0 |
| Total | 19 | 911,985 | 455,996 | 45 | 20 |

*Based on 0.5 kg of crack sealer per linear m
** Sample lost in transit

## 4. TEST RESULTS

### 4.1 "Districts 1-8 Only" Crack Sealer

Crack sealers approved for use in Districts 1-8 only are required to conform with the requirements of OPSS 1212 "Material Specification for Hot-Poured Rubberized Asphalt Joint Sealing Compound" which specifies a maximum cone penetration at 25°C of 90 units and maximum flow of 5 mm. In addition, although not a requirement of the specification, the samples are tested for flow at 50°C, resilience (before and after aging) and a specific gravity determination is carried out. The penetration ratio (pen at 25°C/pen at 50°C) is an indication of the temperature susceptibility of the material. The higher the number, the lower the temperature susceptibility (i.e. improved resistance to temperature change). The specific gravity is determined as an indication of changes in material formulation.

Results of tests carried out on "Districts 1-8 Only" crack sealer are given in Table 2. Four of the six samples tested failed to meet the penetration at 25°C requirement. All six samples met the flow requirement.

**TABLE 2**
**1991 TEST RESULT SUMMARY**
**"DISTRICTS 1-8 ONLY" CRACK SEALER**

| Material | District | Site | Sample No. | Cone Penetration | | | Flow | Resilience (%) | | Specific Gravity |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 25°C | 50°C | Ratio | (mm) | Original | Aged | |
| OPSS 1212 Specification Requirements | | | | 90 max | - | - | 5 max | - | - | - |
| B | No. 2 | Hwy. 3 | 299 | 74 | 172 | 0.43 | 4.0 | 43 | 45 | 1.22 |
| | No. 2 | - | 403 | 66 | 152 | 0.43 | 0.0 | 50 | 48 | 1.27 |
| C | No. 5 | Hwy. 11 | 399 | 122 | 193 | 0.63 | 1.0 | 61 | 62 | 1.17 |
| | No. 5 | Hwy. 26 | 301 | 104 | 183 | 0.57 | 1.0 | 64 | 72 | 1.22 |
| | No. 5 | Hwy. 6/21 | 302 | 95 | 179 | 0.53 | 1.0 | 64 | 72 | 1.23 |
| | No. 5 | Hwy. 12 | 303 | 118 | 200 | 0.59 | 1.0 | 63 | 75 | 1.21 |

### 4.2 "All Districts" Crack Sealer

Samples of "All Districts" crack sealer are tested in the same way as the samples of "Districts 1-8 Only" material but the test results are compared to the test results of the material used for the approval field trial. The properties of the samples must remain essentially unchanged from those of the approval material.

A summary of the test results is given in Table 3.

**TABLE 3**
**1991 TEST RESULT SUMMARY**
**"ALL DISTRICTS" CRACK SEALER**

| Material | District | Site | Sample No. | Cone Penetration | | | Flow | Resilience (%) | | Specific |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 25°C | 50°C | Ratio | (mm) | Original | Aged | Gravity |
| F | Approval Trial Test Results - 1989 | | | 88 | 179 | 0.49 | 0.5 | 44 | 41 | 1.24 |
| | 14 | - | 105 | 77 | - | - | 1.0 | 47 | 45 | 1.29 |
| | 14 | - | 106 | 85 | - | - | 1.0 | 37 | 44 | 1.29 |
| | 14 | - | 107 | 88 | - | - | 1.0 | 32 | 36 | 1.38 |
| | 14 | - | 108 | 96 | - | - | 1.0 | 39 | 42 | 1.29 |
| A | Approval Trial Test Results - 1984 | | | 64 | 127 | 0.50 | 0.0 | 78 | 78 | 1.25 |
| | 1 | - | 346 | 71 | 145 | 0.49 | 0.0 | 65 | 69 | 1.23 |
| | 16 | - | 495 | 76 | 141 | 0.54 | 1.0 | 59 | 65 | 1.19 |
| | 16 | - | 496 | 60 | 116 | 0.52 | 2.0 | 53 | 50 | 1.37 |
| G | Approved Trial Test Results | | | 68 | 104 | 0.65 | 0.0 | 75 | 78 | 1.47 |
| | 18 | Hwy. 17 | 332 | 34 | 107 | 0.32 | 0.5 | 41 | 44 | 1.54 |
| E | No Relevant Test Results from Approval Trial | | | | | | | | | |
| | 20 | Hwy. 17A | 353 | 75 | 152 | 0.49 | 1.0 | 52 | 47 | 1.19 |
| | 13 | - | 396 | 63 | 115 | 0.54 | 0.0 | 46 | 41 | 1.24 |
| | 20 | Hwy.17 | 400 | 69 | 135 | 0.51 | 1.0 | 54 | 45 | 1.20 |
| | 20 | Hwy. 17 | 498 | 76 | 145 | 0.52 | 0.0 | 50 | 46 | 1.20 |
| D | Approval Trial Test Results - 1990 | | | 66 | 145 | 0.46 | 1.0 | 61 | 53 | 1.16 |
| | 17 | Hwy.6 | 453 | 68 | 120 | 0.58 | 1.0 | 67 | 66 | 1.11 |
| | 10 | - | - | 65 | 124 | 0.52 | 1.0 | 61 | 62 | 1.14 |

## 5. DISCUSSION

### 5.1 "Districts 1-8 Only" Test Results

Both samples of material "B" conformed to the specification requirements of OPSS 1212 for both penetration at 25°C and flow.

All four samples of material "C" conformed to the flow requirements of OPSS 1212 but had penetrations at 25°C in excess of the 90 maximum specified. The supplier of material "C" has been informed that future shipments of this crack sealer must comply with the specification requirements or this product may be removed from the DSL.

### 5.2 "All Districts" Test Results

No standard procedure has been established when comparing test values to those obtained at the time of the approval trials. In this analysis it has been assumed that a ten per cent departure from the original values is significant.

Of the four samples of material "F" tested, one had a penetration at 25°C value significantly different from the original test results (77 versus 88). The penetration at 50°C was not determined while all four flow values were satisfactory. Three of the original per cent resilience values were significantly lower than the original value (37, 32 and 39 versus 44) and one of the four aged per cent resilience values was lower than the original (36 versus 41). One specific gravity value was higher than the original (1.38 versus 1.24). The supplier of this crack sealer has been informed that an improvement in the quality of this product is required for any material supplied to the Ministry in the future.

Of the three samples of material "A" tested, two of the penetration at 25°C values were significantly higher than the original test values (71 and 76 versus 64) and two of the penetration at 50°C values were different from the original (145 and 141 versus 127). All of the original and aged per cent resilience values were significantly lower than the original test values while all results for both flow and specific gravity were satisfactory. The supplier of material "A" crack sealer has been informed that an improvement in the quality of any material supplied to the Ministry in the future is required.

The one sample of material "G" had test values significantly different for the penetration at 25°C and both the original and aged per cent resilience. The values of penetration at 50°C, flow and specific gravity were satisfactory. The supplier of material "G" crack sealer has been informed that an improvement in the quality of any material supplied to the Ministry in the future is required.

Relevant test results from the approval trial were not available for material "E" because the supplier had changed from a two component product to a single component product since the approval trial, at the same time assuring the Ministry that the formulation of the material remained unchanged. Its use was therefore allowed to continue. This material was used on a 1991 contract in District 13 and the maintenance personnel reported poor performance of the crack sealer during the winter of 1991/92. Following an inspection of the site by staff of the Engineering Materials Office, it was determined that there was a problem with this product and the supplier has been informed that it has been removed from the DSL. Satisfactory performance in another approval trial will be required before the product can be reinstated.

Two samples of material "D" were tested. Both samples had penetration at 50°C values significantly lower than those obtained at the time of the approval trials and both samples had aged per cent resilience values greater than the original values. Results of the penetration at 25°C, flow, original per cent resilience and specific gravity were satisfactory. The supplier of material "D" crack sealer has been informed that an improvement in the quality of any material supplied to the Ministry in the future is required.

### 5.3 Sample Delivery and Testing Times

Table 4 is a summary of the time in days required for the sample to be sent from the field to the laboratory and the time that elapsed before the samples were tested. The average time for the samples to reach the Downsview laboratory was 13.9 days. The quickest was 2 days and the longest was 37 days.

The average time that the samples were held in the laboratory before testing was 52.7 days. The shortest time was 21 days and the longest time was 78 days.

## 6. CONCLUSIONS

1. The quality level of the "Districts 1-8 Only" crack sealer is not satisfactory as four of the six samples tested did not conform to the specification.

2. The quality level of the "All Districts" crack sealer is not satisfactory as none of the ten samples where comparisons could be made had all properties matching those of the approval samples.

3. One material has been removed from the Designated Sources List owing to its poor performance.

4. Samples were taken on 79 per cent of the crack sealing contracts although the amount of sampling and testing was highly variable. Clarification of the sampling requirements is required.

5. The time delay between sampling and delivery of the sample to the laboratory and testing is too long.

6. Only 44 per cent of the samples submitted to the laboratory were tested.

**TABLE 4**
**SUMMARY OF SAMPLE DELIVERY AND TESTING TIMES**
**1991 CRACK SEALER APPLICATIONS**

| Sample No. | District | Date (Month Day) | | | Time Period (Days) | |
|---|---|---|---|---|---|---|
| | | Sampled | Rec'd in Lab | Tested | From Field to Lab | In Lab Before Testing |
| 105 | 14 | 05 28 | 06 05 | 08 13 | 8 | 69 |
| 106 | 14 | 05 29 | 06 05 | 08 13 | 7 | 69 |
| 107 | 14 | 05 31 | 06 05 | 08 13 | 5 | 69 |
| 108 | 14 | 06 01 | 06 05 | 08 13 | 4 | 69 |
| 299 | 2 | 08 01 | 08 09 | 09 03 | 8 | 25 |
| 301 | 5 | 07 11 | 08 09 | 09 03 | 28 | 25 |
| 302 | 5 | 07 03 | 08 09 | 09 03 | 37 | 25 |
| 303 | 5 | 07 23 | 08 09 | 09 03 | 17 | 25 |
| 332 | 18 | 08 01 | 08 21 | 11 07 | 20 | 78 |
| 346 | 1 | 08 21 | 08 27 | 11 07 | 6 | 72 |
| 353 | 20 | 08 26 | 08 30 | 11 07 | 4 | 69 |
| 399 | 5 | 08 15 | 09 12 | 11 07 | 29 | 57 |
| 495 | 16 | 09 16 | 10 10 | 11 07 | 24 | 28 |
| 496 | 16 | 09 23 | 10 10 | 11 07 | 17 | 28 |
| 396 | 13 | 09 03 | 09 05 | 11 18 | 2 | 74 |
| 400 | 20 | 09 03 | 09 12 | 11 18 | 9 | 67 |
| 498 | 20 | 10 03 | 10 16 | 11 18 | 13 | 33 |
| 403 | 2 | 09 05 | 09 12 | 11 18 | 7 | 67 |
| 453 | 17 | 09 06 | 09 26 | 11 18 | 20 | 53 |
| AVERAGE | | | | | 13.9 | 52.7 |

## 7. RECOMMENDATIONS

1. The Ministry must determine if its crack sealing program is of sufficient importance to warrant the development and maintenance of a rigourous acceptance procedure - which may extend to the implementation of an end-result type of specification. It is recommended that all interested parties be canvassed.

2. If the program is considered sufficiently important, adequate resources of both personnel and equipment must be made available to ensure that all samples submitted are tested within a set time frame. Only if all the samples are tested in a timely manner can a successful acceptance system be implemented.

3. The sampling requirement must be clarified. A revision of Directive B-42 "Minimum Frequencies of Production Sampling and Testing" will be issued in the near future and it is recommended that the frequencies given in that document be adopted on all contracts. Had this policy been adopted on the 19 Ministry contracts in 1991, 49 samples would have been submitted for testing.

4. The quality of crack sealer supplied to the Ministry in 1992 should be carefully monitored. Material which fails to comply with contract requirements should be removed from the DSL. It is recommended that, for the "All Districts" products, a ten per cent departure from the original test values be considered as significant.

5. The inclusion of material "E" in the DSL resulted from a relaxation of the approval requirements. It is recommended that the procedures laid down for the inclusion of these products in the DSL be followed precisely in the future.

## ACKNOWLEDGEMENTS

The cooperation and assistance of the District Maintenance staff is gratefully acknowledged.

# APPENDIX I

ROUT, CLEAN AND SEAL CRACKS IN EXISTING ASPHALTIC PAVEMENT - Item No.

**Scope**

The work of this item shall consist of routing cracks as directed by the Engineer, cleaning the cracks with hot compressed air, and sealing the cracks with a hot poured rubberized asphalt.

**Routing**

The routing operation for cracks shall be carried out with an approved mechanical router capable of cutting out the pavement in a single pass to a width of 40 - 45 mm and a depth of 4 - 8 mm. The Contractor shall demonstrate that the equipment is capable of following meandering cracks and keeping the crack centred within ± 8 mm of the centre of the rout. All subsequent routing shall be within these tolerances.

**Material**

The hot poured rubberized asphalt joint sealing compound shall be on the appropriate list in the MTO Manual of Designated Sources for Materials.

**Sealant Preparation**

The heating kettle shall meet the requirements of the Ontario Fuel Safety Branch, Ministry of Consumer and Commercial Relations.

The joint sealing compound shall be heated in a heating kettle of the indirect heating, double boiler type with a built-in agitator and equipped with indicating thermometers to measure the temperature of both the heat transfer oil and the sealing compound. The compound shall be melted slowly with constant agitation until within the range recommended by the manufacturer for application. Heating above the manufacturer's recommended range is not permitted.

**Cleaning**

Immediately prior to pouring the hot joint sealing compound, the routed grooves shall be cleaned and dried using a hot compressed air lance. The routed grooves shall be treated with hot compressed air until the pavement in the groove is darkened. Not more than two (2) minutes shall elapse before the sealant is placed.

**Placing Sealant**

(a) Application of sealing compound to routed grooves shall be by manual pouring cone, or hose and wand fitted with proper size tip from a low pressure pump from the melter.

(b) Care is to be exercised when filling grooves. The tip of the cone or wand should be placed close to the bottom of the groove to ensure uniform application.

(c) The routed grooves are to be filled with sealing compound so that upon cooling, the sealing compound is flush with the adjacent pavement surface.

(d) During the process of pouring the sealing compound, the Engineer may, at his discretion, require that sufficient sealing compound be taken from the melting unit for testing purposes.

(e) Damage of the sealing compound by construction traffic and Contractor's operation shall be made good by the Contractor at his expense.

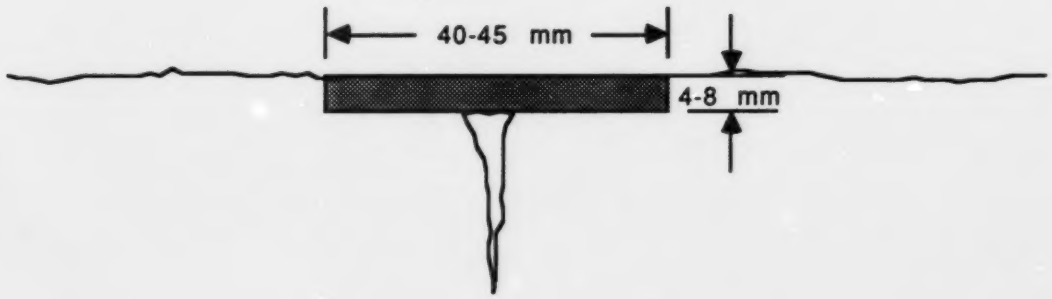
(f) Before opening the lane to traffic, the Contractor shall dust the seals with an appropriate material to remove surface tackiness and remove all routing debris and shall dispose of the debris by conforming to OPSS 510.

**Measurement for Payment**

Measurement in metres shall be made in a line generally representative of the routed groove. Method of measuring shall be by a Metering Wheel.

**Basis of Payment**

The contract price for the above tender item shall be compensation in full for the supply of all labour, equipment, and material required to do the work. No additional payment will be made for sealing compound which flows down into the crack below the rout.




**DESIRED CROSS-SECTION OF SEAL**

WARRANT: Always with this tender item.

NOTE: This method of crack sealing is suitable for cracks up to a maximum width of 10mm.